

Socioeconomic Status and Mortality

Contribution of health care access and psychological distress among U.S. adults with diagnosed diabetes

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OBJECTIVE—Although several studies have examined the association between socioeconomic status (SES) and mortality in the general population, few have investigated this relationship among people with diabetes. This study sought to determine how risk of mortality associated with measures of SES among adults with diagnosed diabetes is mitigated by association with demographics, comorbidities, diabetes treatment, psychological distress, or health care access and utilization.

RESEARCH DESIGN AND METHODS—The study included 6,177 adults aged 25 years or older with diagnosed diabetes who participated in the National Health Interview Surveys (1997–2003) linked to mortality data (follow-up through 2006). SES was measured by education attained, financial wealth (either stocks/dividends or home ownership), and income-to-poverty ratio.

RESULTS—In unadjusted analysis, risk of death was significantly greater for people with lower levels of education and income-to-poverty ratio than for those at the highest levels. After adjusting for demographics, comorbidities, diabetes treatment and duration, health care access, and psychological distress variables, the association with greater risk of death remained significant only for people with the lowest level of education (relative hazard 1.52 [95% CI 1.04–2.23]). After multivariate adjustment, the risk of death was significantly greater for people without certain measures of financial wealth (e.g., stocks, home ownership) (1.56 [1.07–2.27]) than for those with them.

CONCLUSIONS—The findings suggest that after adjustments for demographics, health care access, and psychological distress, the level of education attained and financial wealth remain strong predictors of mortality risk among adults with diabetes.

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Socioeconomic status (SES) is a complex construct determined by an individual's or group's relative position within a society (1) and based on socially derived economic factors. These relative levels of position within the societal hierarchy may result in inequalities in health. In epidemiologic research, SES is most commonly measured in terms of education, income, occupational social class, and, less often, financial wealth (1–4). Occupational social class often relates to whether an individual is employed in, for example, a

nonmanagerial, managerial, working class, or professional capacity. Financial wealth relates to the accumulated assets of an individual, often measured in terms of investments, savings, home ownership, or other sources of economic security. However, recent empirical evidence indicates that these measures are not equally accurate indicators of SES (5,6).

Epidemiologic studies using a variety of SES measures have consistently shown that, in the general population, mortality risk increases as SES decreases (7–11).

Furthermore, there is evidence that the influence of SES is cumulative over an individual's life (11).

Adults with low SES are disproportionately affected by diabetes and its complications (12). Among adults with diabetes, lower SES is associated with many factors known to contribute to poor health outcomes, including reduced access to and underuse of recommended preventive care, poor metabolic control, and psychological distress (12). Studies have examined the association between SES and mortality from diabetes in the general population (13,14) and the relationship of SES and mortality among people with diabetes (15–21). However, most studies have focused on only one measure of SES (13,15,16) or have used area-based SES measures (19,20). Furthermore, although some studies have included behavioral and clinical characteristics (18,21), none have included additional measures such as health care access and use or psychological factors.

Many possible factors may explain the associations of SES with mortality risk (22–24), including poorer overall health, increased number of comorbid conditions, lack of access to or underuse of health care services, and psychological factors. Psychological factors including depression, anxiety, or emotional problems may influence acute and chronic cardiovascular disease risk and overall health (25–27). A previous national study showed that adults with diagnosed diabetes and comorbid depression have a greater than twofold increased risk of mortality (25). Lower SES is associated with increased risk of mortality among adults with or without diagnosed diabetes and among people with depression (28).

Although several studies have examined the association between socioeconomic position and mortality in the general population, few have investigated the relationship among people with diabetes, and fewer still have evaluated the contribution of health care access and psychological distress to this relationship. Therefore, we designed this study to 1) determine whether increased risk of mortality is associated with SES measures

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among adults with diagnosed diabetes, and 2) determine whether increased risk is mitigated by the association of demographic factors, comorbidities, diabetes treatment and duration, health care access and utilization, or psychological distress.

RESEARCH DESIGN AND METHODS

We used data from the National Health Interview Survey (NHIS) and the NHIS's Linked Mortality Files. The NHIS is an annual, cross-sectional, in-person household interview survey of the civilian noninstitutionalized population of the U.S. conducted by the Centers for Disease Control and Prevention, National Center for Health Statistics (NCHS). It collects social, demographic, and health information from participants. The final annual response rate of sample adults completing the NHIS is approximately 70%. Descriptions of the NHIS design have been published elsewhere (29). The NCHS periodically conducts mortality follow-up for eligible NHIS participants through probabilistic record linkage to the National Death Index (NDI). To be eligible for linkage to the NDI, one or more of the following data must be in the NHIS database: participant's full name, sex, date of birth, or social security number. A complete description of the methodology used to link NHIS records to the NDI can be found elsewhere (30). We completed NDI follow-up for all eligible participants in the NHIS.

We compiled data from 7 years of the NHIS (1997–2003) for eligible participants for whom there were publicly available mortality follow-up data from the time of their interview through 31 December 2006. We selected these years for inclusion because similar sample and survey designs were used for all 7 years. We included a sample of adults from the NHIS who reported being diagnosed with diabetes by a health care professional at the time of interview, were ≥ 25 years of age at the time of interview, and were considered eligible for mortality follow-up. We selected ≥ 25 years of age to prevent misclassification due to changing education status. This produced a total analytic sample of 6,177 persons.

Socioeconomic measures

For indicators of individual SES, we chose educational attainment, financial wealth, and family income of the NHIS participant. This information was reported by the participant or a family member at the

time of the NHIS interview. Education was measured as the highest level of education completed by the respondent and was categorized as less than a high school diploma, high school diploma or General Educational Development test (GED) equivalent, some college, or at least a college degree.

We measured financial wealth based on self-report of whether a participant owned stocks, received dividends, or owned a home. Participants were asked if they owned stocks or received income from dividends, mutual funds, estates, trusts, or rental properties. Participants also were asked if they owned the home in which they were living. We categorized a participant's financial wealth as none (having no stocks/dividends and not owning a home), or either having stocks/dividends, owning a home, or both. In univariate and proportional hazards analyses there were no differences observed between the groups having either having stocks/dividends or owning a home or having both, so we combined these two groups into one.

Family income was represented as a percentage of the established income-to-poverty ratio (IPR), calculated as the family's income divided by the federal poverty level (defined as 100% in the categories that follow). Families were categorized as having an IPR of <100 , 100–199, 200–299, 300–399, or $\geq 400\%$ IPR. We chose IPR because it takes into account family size and is revised annually to reflect changes in cost of living as measured by the Consumer Price Index (31). There was a substantial amount of missing data (~ 20 –29%) for the NHIS detailed annual family income question for the years 1997–2003. For those participants who did not report their income, we used values from a multiple imputation provided and recommended by NCHS (32).

Baseline characteristics

Each participant's age, sex, race/ethnicity, and U.S. birth status were based on self-report during the interview. Diabetes-specific variables obtained from the NHIS included diabetes treatment (insulin alone, oral medications alone, combination of oral medications and insulin, or none) and age at diabetes diagnosis. Type 1 diabetes was defined as age at diabetes diagnosis as <30 years and use of insulin alone. BMI was calculated as self-reported weight in kilograms divided by self-reported height in meters squared. We also included self-rated health status

(excellent, very good, good, fair or poor) and report of functional limitation. Functional limitation was based on self-reported difficulty with one or more of the following activities: walking, climbing, standing, sitting, stooping, reaching, grasping, carrying, pushing, shopping, social activities, or relaxing. We included the number of comorbid conditions in addition to diabetes for each participant. Comorbid conditions, based on self-report of diagnosis by a health care professional, included angina, heart attack, coronary heart disease, stroke, hypertension, cancer, kidney disease, asthma, emphysema, and chronic bronchitis.

To determine whether access to health care influenced the relationship of SES and mortality, we used three separate measures based on whether the participant had health insurance, had a place where they receive routine health care, or had not received medical care because of cost. Health insurance was categorized as private; public insurance only; or no health insurance (participants could have both private and public insurance).

We also included a measure of self-report of psychological distress based on the Kessler 6 scale, which assesses nonspecific psychological distress. A participant with a score of ≥ 13 was considered to have serious psychological distress (33).

All-cause mortality

Based on a probabilistic match to the NDI, there were 566 deaths among NHIS participants through 31 December 2006. Person-years (py) were calculated from a baseline date of the NHIS interview to either date of death or end of follow-up period (31 December 2006), whichever came first. The mean follow-up was 6 py.

Statistical methods

We analyzed only data from those adults in the sample with a self-report of diabetes and who were eligible for mortality follow-up, who were ≥ 25 years old at the time of the NHIS interview, and who had no missing values for cause of death or other covariates. This process identified 6,177 eligible participants. Survey weights, including the eligibility-adjusted weights from the mortality files, were applied to make study estimates representative of the noninstitutionalized U.S. adult population with diabetes. Analyses were conducted using SUDAAN statistical analysis software, version 10 (RTI International,

Research Triangle Park, NC) to account for the complex NHIS survey design.

We compared participants' baseline assessments by SES measures using a χ^2 test. We considered $P < 0.05$ to be statistically significant. We calculated mortality rates per 100 py at risk, categorized by educational attainment, financial wealth, and family income. We also used the Cox proportional hazards regression model to determine the relative hazard (RH) of mortality categorized by each SES indicator individually, adjusted for the other SES indicators. Graphs of the log-log plot of the RH values by time showed that the assumption of proportional hazards was met.

To determine whether differences in all-cause mortality by education, financial wealth, or family income could be explained by other variables, we constructed a series of proportional hazards models for each SES indicator separately and then a model with all three measures of SES. Our base models included only the SES indicator (education level, financial wealth, or family income). Model 1 adjusted for demographics; model 2 added variables related to diabetes, BMI, comorbidities, self-reported health status, and functional limitation; model 3 added variables related to health care access; and model 4 added a measure of psychological distress.

To test statistically whether the additional variables significantly changed the model, we used the log-likelihood ratio test (34). This test was applied to the models using measures of education and financial wealth for determining SES but not to models that used income measures. This was because of the multiple imputation of that measure (the likelihood ratio is not included in the output from these models). Finally, we included all SES indicators in a model adjusted for all other covariates. We tested for multiplicative interactions between SES indicators and sex, age, and race/ethnicity. None of the results was statistically significant at the $P < 0.05$ level. To determine whether the results differed by type of diabetes, we performed sensitivity analysis excluding all adults with type 1 diabetes.

RESULTS—The baseline characteristics of our cohort overall and by SES measures are presented in Table 1. Among the eligible population of adults with diagnosed diabetes, 18.6% reported having less

than a high school diploma; 28.5% reported having a high school diploma or GED equivalent; 27.8% reported some college; and 25.0% reported a college degree or higher. Only 8.6% reported neither having stocks nor owning a home as a measure of wealth. For family income, 12.3% were at $<100\%$ of IPR, 17.8% were between 100 and 199% of IPR, 33.0% were between 200 and 399% of IPR, and 36.5% were at $>400\%$ of IPR.

Demographic characteristics, including percentage aged >65 years, sex, race, or ethnicity, and whether an individual was born in the U.S., differed by each SES measure. Diabetes duration, functional limitations, self-rated health status, report of having or not having health insurance, and report of not receiving medical care because of cost also differed by SES measure. Diabetes treatment, type of diabetes, BMI, number of comorbid conditions, having a place for routine care, and psychological distress did not differ by SES measure.

Overall mortality among adults aged ≥ 25 years with diagnosed diabetes in the U.S. was 1.03 per 100 py (Table 2). Mortality differed by SES measure. For education, those with less than a high school diploma had the highest mortality (2.09 per 100 py), followed by high school graduates (1.08 per 100 py), those having some college education (0.74 per 100 py), and college graduates (0.53 per 100 py). For financial wealth, mortality was highest for those owning neither stocks nor a home (1.22 per 100 py) compared with those owning stocks, a home, or both (1.01 per 100 py). A similar pattern also was observed for income, with the lower levels having the highest mortality (IPR $<100\%$, 1.35 per 100 py and 100–199%, 1.66 per 100 py) followed by IPR 200–399% (1.16 per 100 py) and IPR $\geq 400\%$ (0.52 per 100 py).

We next looked at the effect of the following variables on the association of each SES measure with mortality: demographics (model 1); then adding diabetes measures and comorbidities (model 2); next adding health care access and utilization (model 3); and, finally, adding psychological distress (model 4). The results of these analyses are shown in Table 3.

In unadjusted analysis, there was almost a fourfold higher risk of death among adults with diabetes who had less than a high school diploma compared with those who had a college or

postgraduate degree or both. However, after adjusting for demographics, the risk was attenuated to only twofold higher. After adjusting further for diabetes measures and comorbidity variables, health care access and utilization, and psychological distress, there was still a significantly increased risk of death among adults with diabetes having less than a high school diploma compared with college graduates (RH 1.52 [95% CI 1.04–2.23]). Based on the results from the log-likelihood ratio test, the group with the demographic variable added (model 1), the group with the diabetes and comorbidities variable added (model 2), and the groups with the health care and utilization variable added (model 3) and the psychosocial distress variable added (model 4) each contribute significantly to the model.

The associations for financial wealth were slightly different. In unadjusted analysis, having no financial wealth (owning neither stocks nor a home) was not associated with an increased risk of death compared with having financial wealth (owning stocks, a home, or both). However, after adjusting for demographic factors and the variables in models 2, 3, and 4, there was an increased risk of death among those having no financial wealth compared with those having financial wealth (RH 1.56 [95% CI 1.07–2.27]). Based on results for the log-likelihood ratio test, the groups with the demographic variable added (model 1), the diabetes and comorbidities variable added (model 2), and the health care and utilization variable added (model 3) indicated increased risk of death relative to the base models for financial wealth. Results from analysis of the group with the psychosocial distress variable added (model 4) did not indicate significant additional risk.

Risk of death relative to income (by percentage of IPR) followed a pattern similar to that observed by education level. In unadjusted analysis, there was more than a twofold increased risk of death for those at $<100\%$ of IPR and those between 100 and 299% of IPR compared with adults at $>400\%$ of IPR. After adjustment for demographic variables, lower IPR still was significantly associated with an increased risk of mortality. However, after adjusting for diabetes measures and comorbidity variables, health care access and utilization, and psychological distress, there was no statistically significant increased risk of death for adults with diabetes at any IPR compared with

Table 1—Baseline characteristics of adults aged ≥ 25 years with diagnosed diabetes by measures of SES, National Health Interview Survey, 1997–2003

Characteristics	Total (N = 6,177)	Education			Financial wealth			IPR			
		<High school (n = 1,355)	High school/ GED (n = 1,694)	Some college (n = 1,676)	≥College (n = 1,412)	No stocks/ home (n = 747)	Stocks, home, or both (n = 5,404)	<100% (n = 998)	100–199% (n = 1,256)	200–399% (n = 1,975)	≥400% (n = 1,947)
Demographics											
Age, mean years (SE)	49.2 (0.26)	55.1 (0.57)	50.1 (0.44)	46.8 (0.45)	46.3 (0.44)	44.3 (0.70)	49.6 (0.27)	47.8 (0.65)	51.7 (0.68)	50.7 (0.45)	47.1 (0.35)
Male*†‡	51.4 (0.77)	49.2 (1.61)	48.9 (1.48)	51.7 (1.37)	55.4 (1.49)	47.1 (2.21)	51.7 (0.80)	39.2 (2.06)	46.8 (1.85)	52.6 (1.35)	56.6 (1.33)
Non-Hispanic white*†‡	72.9 (1.16)	52.3 (2.26)	75.6 (1.50)	76.8 (1.45)	81.3 (1.36)	52.0 (2.54)	74.8 (1.13)	47.8 (2.67)	62.4 (2.28)	76.2 (1.43)	83.3 (1.17)
U.S. born*†	86.3 (0.73)	75.9 (1.76)	89.0 (1.14)	89.7 (0.96)	87.7 (1.04)	79.2 (1.90)	86.9 (0.74)	72.2 (2.55)	81.2 (1.73)	89.2 (1.15)	90.1 (0.97)
Biological											
BMI, mean kg/m ² (SE)	33.1 (0.22)	33.4 (0.56)	33.1 (0.40)	32.6 (0.37)	33.6 (0.47)	32.5 (0.57)	33.1 (0.23)	33.3 (0.65)	32.7 (0.49)	32.9 (0.38)	33.4 (0.41)
Diabetes duration, mean years (SE)*†	9.8 (0.21)	13.2 (0.46)	10.5 (0.43)	8.5 (0.36)	8.1 (0.36)	8.2 (0.51)	10.0 (0.22)	9.27 (0.52)	12.1 (0.56)	10.4 (0.41)	8.5 (0.33)
Type 1 diabetes	4.0 (0.30)	3.9 (0.60)	3.6 (0.51)	4.5 (0.62)	3.8 (0.56)	5.1 (1.01)	3.9 (0.31)	3.4 (0.74)	4.8 (0.85)	3.3 (0.50)	4.4 (0.51)
Oral hypoglycemic											
pills alone	55.1 (0.75)	53.4 (1.76)	55.8 (1.48)	55.5 (1.40)	55.0 (1.46)	49.8 (2.07)	55.5 (0.80)	54.8 (2.01)	55.4 (1.83)	54.8 (1.43)	55.2 (1.36)
Functional limitation*†‡	65.1 (0.70)	61.1 (1.61)	65.8 (1.38)	64.0 (1.39)	68.9 (1.42)	68.0 (1.98)	64.8 (0.75)	61.9 (2.04)	64.6 (1.65)	65.2 (1.26)	66.5 (1.34)
Self-rated health fair/poor*†‡	14.7 (0.56)	35.0 (1.60)	15.4 (1.05)	10.4 (0.84)	3.0 (0.49)	20.2 (1.71)	14.1 (0.58)	33.6 (1.98)	22.9 (1.45)	14.0 (1.00)	5.0 (0.60)
≥3 comorbid conditions§	24.2 (0.62)	21.9 (1.29)	23.9 (1.19)	24.0 (1.17)	26.6 (1.34)	23.9 (1.90)	24.2 (0.65)	22.9 (1.67)	22.7 (1.47)	25.0 (1.12)	24.5 (1.07)
Access to health care											
No health care insurance*†‡¶	15.8 (0.56)	18.4 (1.27)	16.2 (1.01)	16.4 (1.06)	12.9 (0.93)	52.7 (2.38)	12.3 (0.53)	21.1 (1.67)	18.2 (1.24)	15.3 (0.99)	13.1 (0.87)
Psychological distress											
Serious (Kessler 6 score ≥13)	6.0 (0.34)	6.0 (0.76)	6.3 (0.71)	5.7 (0.60)	6.2 (0.61)	7.3 (1.04)	5.9 (0.37)	6.4 (0.95)	6.1 (0.87)	6.1 (0.63)	5.9 (0.62)

Data are % (SE) unless otherwise indicated. * $P < 0.05$ among education groups. † $P < 0.05$ among financial wealth groups. ‡ $P < 0.05$ among poverty groups. §Self-reported history of angina, myocardial infarction (heart attack), coronary heart disease, stroke, hypertension, cancer, kidney disease, asthma, emphysema, chronic bronchitis, or a combination of these. ¶Private insurance includes report of private insurance alone or in combination with public insurance.

Table 2—Mortality per 100 py among adults aged 25 years and older with self-report of diagnosed diabetes, National Health Interview Survey, 1997–2003, with follow-up through 31 December 2006

	Deaths, n	PY, n	Mortality per 100 py (SE)
Overall (n = 6,177)	566	11,489	1.03 (0.180)
Education (n = 6,137)			
<HS	231	2,632	2.09 (0.182)
HS graduate or GED equivalent	160	3,237	1.08 (0.110)
Some college	113	3,033	0.74 (0.092)
College graduate or higher	58	2,589	0.53 (0.082)
Financial wealth (n = 6,151)			
No stocks/dividends or home ownership	83	1,158	1.22 (0.180)
Stocks/dividends or home ownership	482	10,303	1.01 (0.061)
IPR (n = 6,177)			
<100%	116	1,645	1.35 (0.176)
100–199%	185	2,333	1.66 (0.184)
200–399%	191	3,681	1.16 (0.110)
≥400%	74	4,027	0.52 (0.085)

HS, high school.

the group at the highest percentage of IPR.

We included all three measures of SES simultaneously in the proportional hazards models (Supplementary Table 1). In this analysis, the increased risk of death for no financial wealth remained and was similar to the estimates without adjusting for education and federal poverty level

(RH 1.47 [95% CI 1.01–2.15]). Among the education categories, only less than high school education was associated with an increased risk (1.70 [1.06–2.71]). IPR (family income) was found to be not significantly associated with an increased risk of death.

We repeated the analysis excluding adults with type 1 diabetes based on

self-report of age of diagnosis <30 years and only using insulin (n = 236). There was no significant change in the overall mortality (1.04 per 100 py) or mortality by SES (Supplementary Table 2). Results were also similar in unadjusted and adjusted proportional hazards models for education and financial wealth and were attenuated for IPR after excluding type 1 diabetes (Supplementary Table 2).

CONCLUSIONS—After adjusting demographic factors, comorbidities, diabetes treatment and duration, health care access and utilization, and psychological distress, we found that there was still an increased risk of mortality for lower education levels or less financial wealth among adults with diagnosed diabetes in the U.S. However, after adjusting for these factors, there was no association between lower percentage of IPR and increased risk of mortality.

The SES construct is complex and difficult to measure. Nonetheless, in our analysis we found that, regardless of the measure we used, there was an inverse gradient of association for SES with mortality in unadjusted analyses among adults with diagnosed diabetes. When measuring SES by financial wealth and education, the increased risk of mortality cannot be fully explained by lack of access

Table 3—All-cause mortality by SES among adults aged ≥25 years with self-report of diagnosed diabetes, National Health Interview Survey, 1997–2003, with follow-up through 31 December 2006

SES measure	Unadjusted	Model 1†	Model 2‡	Model 3§	Model 4¶
Education					
<High school	3.95 (2.75–5.69)	2.16 (1.52–3.03)	1.44 (0.99–2.08)	1.50 (1.03–2.19)	1.52 (1.04–2.23)
High school graduate	2.04 (1.39–2.99)	1.52 (1.05–2.19)	1.15 (0.79–1.68)	1.21 (0.82–1.78)	1.23 (0.83–1.81)
Some college	1.40 (0.93–2.11)	1.36 (0.91–2.01)	1.12 (0.75–1.67)	1.15 (0.76–1.73)	1.17 (0.77–1.76)
College graduate or higher	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Financial wealth					
Owns neither a home nor stocks/dividends	1.19 (0.85–1.66)	1.93 (1.37–2.73)	1.56 (1.07–2.29)	1.56 (1.07–2.28)	1.56 (1.07–2.27)
Owns a home, stocks/dividends, or both	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
IPR 					
<100%	2.62 (1.71–4.02)	2.32 (1.44–3.75)	1.39 (0.82–2.37)	1.32 (0.75–2.31)	1.31 (0.74–2.29)
100–199%	3.21 (2.08–4.96)	2.21 (1.36–3.57)	1.56 (0.95–2.58)	1.49 (0.89–2.51)	1.49 (0.89–2.50)
200–399%	2.44 (1.54–3.26)	1.55 (1.02–2.36)	1.19 (0.77–1.81)	1.16 (0.75–1.80)	1.16 (0.75–1.79)
≥400%	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)

Data are proportional hazards models (95% CI). Reference group indicated by (reference). †Log-likelihood ratio $P < 0.001$ comparing model 1 with unadjusted model. Variables include SES measure and age (continuous); sex; race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, other); and born in the United States. ‡Log-likelihood ratio $P < 0.001$ comparing model 2 with model 1. Variables include those in model 1 plus diabetes treatment (insulin alone, oral meds alone, combination, no reported treatment); diabetes duration (years, continuous); functional limitation (yes/no); number of comorbidities (0, 1–2, ≥3); and self-reported health (poor/fair, good, very good/excellent). §Log-likelihood ratio $P < 0.001$ comparing model 3 with model 2. Variables include those in model 2 plus health insurance status (private insurance, public insurance, no insurance); access to care (Do you have a place you usually go for care?); and cost of care (Did you not seek medical care in past year because of cost?). ¶Log-likelihood ratio $P < 0.001$ comparing model 4 with model 3. Variables include those in model 3 plus report of psychosocial distress (score of ≥13 on Kessler 6 scale). ||IPR models not tested.

to health care or psychological distress. Our results confirm previous findings that show the patterns of mortality among adults with diagnosed diabetes are associated with SES and are similar to findings observed in the general population (15–21,35,36). These studies showed that among adults both with and without diabetes, those with lower levels of education and income have a higher risk of mortality. In addition, recent studies have shown that lack of financial wealth (defined as not owning a home or other assets) is also associated with higher mortality and may be a better indicator of overall SES, particularly as it relates to health (37).

Education and financial wealth are measures of SES that are more likely to persist over a lifetime. Attained education influences later earning potential and likely influences health literacy, which also is associated with risk of mortality (38). Most individuals attain their highest level of education by age 25. Financial wealth is an accumulation of resources and inheritance early in life and throughout adulthood (39).

In contrast, income reflects resources as a snapshot in time, subject to fluctuation over a lifetime. Therefore, in contrast to education and financial wealth, the association of income with other factors linked to mortality may be stronger because reported income coincides in time with the other measures. Also, income in itself may reflect a consequence of poor health. Income is an important predictor of mortality. A recent study of the relationship between income and mortality over time in the U.S. found a highly curvilinear gradient in the relationship, with individuals in the lower 30% percent of the income distribution having the highest mortality risk (40). Recent analysis of the Framingham Offspring Study found that, among women, cumulative SES (as measured by father's education, participant's education, and participant's occupation) was inversely associated with risk of diabetes incidence (41), so that a greater proportion of individuals with diabetes also have lower cumulative SES.

We found that when controlled for demographic factors, the effects of education and income on mortality among adults with diabetes seem to be largely accounted for by clinical factors. This indicates that education and poverty likely influence mortality risk through their strong association with the clinical

factors present at baseline or because the prevalence of the clinical variables are significantly more common among people with lower levels of education and income.

Research has not examined whether the types of diabetes influence differently the association of SES and mortality. Previous studies that include measurement of diabetes type have been comprised entirely of individuals with either type 1 diabetes (18) or type 2 diabetes (19,21). Many studies did not attempt to distinguish diabetes type (15,16,20), although based on the percent of diabetes cases that are type 1, it is likely that the majority of individuals with diabetes in these studies had type 2 diabetes. We attempted to distinguish between type 1 and type 2 diabetes based on self-reported diabetes treatment and age at diagnosis. There was no difference in our study population by SES measures and diabetes type, nor did excluding those with type 1 diabetes significantly change the results.

This study has a number of limitations. The NHIS only includes self-reported diabetes characteristics, comorbidities, health care access and utilization, and psychological distress. It is unknown whether there is differential reporting for these measures by SES and if so in what direction the misreporting occurs. If individuals with lower SES are more likely to underreport measures such as obesity, this may explain the lack of association found. The measures of SES are based on self-report and are captured at only one point in time. We do not know how these measures of SES or any of the covariates may or may not have changed over a longer follow-up period because follow-up was only available for a mean of 6 years. Although we used the imputed income provided by the NCHS to address the missing income, misclassification and error with these imputations may exist. Also, because only self-report of diabetes diagnosis is available in the NHIS, we may be missing individuals who have undetected diabetes. If the prevalence of undetected diabetes is similar for all SES groups, then this would not likely bias the results. However, if the proportion of undetected diabetes differs by SES, this may influence the relative risk of mortality. Finally, the NHIS's requirements for eligibility for linkage to mortality data have differed over the years. We have attempted to address this limitation by using the eligibility-adjusted weights provided with the data.

The study also has a number of strengths. The study's sample of noninstitutionalized adults diagnosed with diabetes was large and was nationally representative (29). Also, this is, to our knowledge, the first study to examine the relationship of three separate measures of SES with mortality among adults diagnosed with diabetes and to be adjusted for potential effect modifiers such as diabetes duration and treatment, health care access, and psychological distress.

Among this population with diagnosed diabetes, the association of education and financial wealth persisted after accounting for other known health indicators. Further research is needed to fully tease apart this complex relationship and understand the underlying mechanisms. One possible area of further research is to include contextual levels (neighborhood or community) of SES. In the meantime, clinicians and public health workers may need to provide more targeted health information to people with lower SES with diagnosed diabetes.

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